



CONSERVATION ECOLOGY

Embracing Invasives

The Galápagos, one of biodiversity's hot spots, has become a test case for a controversial approach to ecosystem management

GALÁPAGOS, ECUADOR—Driving uphill on Santa Cruz, one of the four inhabited islands of the Galápagos, Mark Gardener pauses to let a lumbering giant tortoise heave its 400-kilogram bulk across the tarmac. Here in the cloud forest, Galápagos finches chatter in a pale-barked, evergreen scalesia tree, its branches laden with epiphytes and lichens. Below are coastal mangroves and the golden prickly pear of the arid lowlands; in the highlands above us, the fog-laden air is wetter and the undergrowth, denser. Among a waist-high tangle of brambles and ferns, a rare rusty-leaved miconia shrub fights through, holding up its lilac flowers like a flag of defiance against the introduced weeds that threaten its once-ubiquitous existence.

Much of the fauna and flora of these islands is unique, but introduced species are taking over. These humid highlands are now a hodgepodge woodland of nonnatives, such as guava and passion fruit, and endemics, such as scalesia and guayabillo, all broken up and intruded on by agricultural plots.

Gardener has spent the past 2 decades trying to “purify” the islands’ ecosystems. But now he’s changing tack. “As scientists and conservationists, we need to recognize that we’ve failed: Galápagos will never be pristine,” says Gardener, head of restoration at the Charles Darwin Research Station (CDRS), which coordinates most of the conservation and research on the Galápagos. “It’s time to embrace the aliens.”

The sun-aged Australian researcher, with his russet beard, open sandals, and shell-pendant necklace, holds up a thorny creeper with its small, sour fruit—a transplant from Asia—and smiles sadly: “Blackberries now cover more than 30,000 hectares here, and our studies show that island biodiversity is reduced by at least 50% when it’s present. But as far as I am concerned, it’s now a Galápagos native, and it’s time we accepted it as such.”

Charles Darwin noted 17 introduced species on his visit in 1835, just 3 years after humans first started permanently living on the islands. Today, humans have intentionally or unintentionally introduced about 900 plant species into the Galápagos.

Rallying to the endemics’ cause, conser-

vationists, led by CDRS scientists, have spent the past 50 years attempting to remove introduced species and restore the islands’ flora and fauna to prehuman days. There have been some successes: Goats have been eliminated from several islands.

But in the battle for survival of the species, the aliens have been winning. The attempt by conservationists to eradicate blackberry, guava, and 34 other invasive plant species has cost more than \$1 million and succeeded in eliminating just four. The most invasive and problematic of these aliens—blackberry and guava—have developed into forests where nothing else grows, birds cannot nest, and even insects are rare. As a result, the cloud forest’s *Scalesia pedunculata*, for example, has been reduced by 97% on Santa Cruz alone.

The main reason for this failure, Gardener says, is that invasive plants are far more competitive than native plants. Seeds of invasive species, such as blackberries (*Rubus niveus*, also known as the Mysore, or hill, raspberry) are long-lived and accumulate in high numbers in the soil. “Many restoration activities fail because the disturbance they create actually stimulates these seeds to germinate, so we are stuck in a vicious cycle,” he says.

Now, Gardener is saying, enough. He points out that despite nonnative invasions, for example, the Galápagos remains one of the most pristine ecosystems left on our planet, boasting 95% of its original biodiversity. So he is joining forces with a group of maverick ecologists who for the past 5 years have promoted the idea that the addition of nonnative species to natives in a region leads to “novel” or “hybrid” ecosystems that have ecological value and may be worthy of conservation. “We need to find ways to optimize these new



Shifting ecosystems. Given the loss of the *Scalesia pedunculata* cloud forest (above and top), Mark Gardener (left) favors accepting nonnative species.

CREDITS: (TOP LEFT) NICK PATTINSON; (TOP RIGHT) ADAPTED FROM ALEKSANDR VOLKOV/ISTOCKPHOTO.COM; (BOTTOM PHOTOS) NICK PATTINSON

Downloaded from www.sciencemag.org on August 30, 2011

ecosystems,” Gardener says.

In practice, this means accepting benign species, such as banana, as “new natives.” Instead of trying to get rid of blackberry, guava, and other invasives, the new goal is simply to limit their numbers and spread so they no longer overwhelm native vegetation, possibly through biological control.

Several other places are trying to do likewise. In Panama and Puerto Rico, conservationists have decided not to fight teak and the African tulip tree, for example, but to value them as part of the changing world we live in. Next month, Hawaii joins their ranks, with a \$1.6 million grant to look at preserving native species within a hybrid ecosystem on a military reservation. In addition, the U.S. Forest Service has concluded that restoring Hawaii’s tropical forests to their historic state is “no longer financially or physically feasible.”

But Gardener’s decision to abandon the fight to preserve and restore indigenous-only species here has caused shock waves among the venerable members of the Charles Darwin Foundation, the 50-year-old organization that runs CDRS, with many of the old guard “very upset by the idea,” Gardener says. William Laurance, a conservation ecologist at James Cook University in Cairns, Australia, is also concerned: “If people want to resign themselves to managing novel ecosystems—and it sounds like that’s the reality they face on the Galápagos—then what we’re doing is homogenizing the world’s biota; setting the world on a geological epoch: the Homogocene.”

Conservation controversy

Gardener is taking his cue from ecologist Richard Hobbs of the University of Western Australia in Crawley. In 2006, Hobbs and 17 colleagues argued in *Global Ecology and Biogeography* that novel ecosystems have value in promoting biodiversity and help with services such as providing flowers for pollinators or cycling nutrients. Thus, they should be studied scientifically.

That same year, S. Joseph Wright and Helene Muller-Landau of the Smithsonian Tropical Research Institute (STRI) in Panama compared the number of species in undisturbed old-growth forest and mixed, nonnative forests in Panama. They concluded that biodiversity levels in hybrid ecosystems may be the same or actually far exceed those in comparable native forests. The finding challenged the dogma that the conversion of pris-

tine forests to novel ecosystems would necessarily lead to a swath of extinctions.

The papers provided a new perspective on what others tended to call degraded or junk ecosystems. Nonetheless, those for whom conservation means returning a forest to its “natural,” prehuman Eden were horrified. “Dr. Wright’s views have kicked off one of the most heated scientific controversies of the past decade,” Laurance says.

“I have been scolded, yelled at, and abused by the ‘conservation priests,’” says Ariel Lugo, director of the International Institute of Tropical Forestry in San Juan, Puerto Rico, and a co-author of the Hobbs paper. “Whenever I talk at a conference and give our latest results, I’m met by absolute silence and then, often, hostility from the old guard.”

Laurance, head of the critics’ camp, says the biodiversity in primary and novel eco-



Alien invader. Blackberry’s carpet of brambles has overwhelmed native ecosystems on the Galápagos.

systems is not equivalent because the latter have more “junk species,” which thrive in many places. “We need to protect the rare plants and animals that are found in primary forests,” he argues. In many comparative biodiversity studies, novel ecosystems do well only because of their proximity to pristine forests, he cautions: “The weedy exotics get a subsidy of immigrants from primary forest, which boosts their diversity figures.”

The controversy came to a head in 2008 during what Lugo describes as a “highly volatile” meeting held at STRI. The outcome was a grudging acceptance that secondary forests do have conservation value. Nonnatives can help a heavily impacted area regain its diversity by creating canopy, stabilizing the soil, or retaining moisture. Thus endemic plants, which often take longer to reestablish themselves on former pasture or at the edges of agricultural land, can benefit from the shade offered by faster-growing, nonnative trees, like cedar.

And in the Galápagos, Tobias Dittmann, a botanist at the University of Hohenheim in Stuttgart, Germany, finds that this introduced tree has no negative effect on biodiversity. Dittmann looked at the biodiversity along a continuum of degraded habitats—from remnant scalesia forest to abandoned pasture—in Santa Cruz. He determined that a remnant scalesia forest has a biodiversity similar to a mixed introduced forest dominated by cedar.

There are also economic considerations in favor of these hybrid ecosystems. Gardener argues that with 30,000 people now living in the Galápagos, ecosystem planning must address human needs, such as providing timber, grazing, or shade or limiting erosion, in addition to nurturing biodiversity. Cedar is a valuable timber, bringing more than \$2 million annually to the local economy, for example. “Furthermore, coffee grown with an overstory of scalesia had an intermediate level of biodiversity,” Gardener says. “So, it seems that novel ecosystems, such as mixed introduced forest and coffee-scalesia, could be an alternative restoration objective.”

It’s still early days for this new ecology, and much is unknown. Ecosystems are naturally in a state of flux, and novel forests are just that, novel. “The oldest novel ecosystem we’ve studied in Puerto Rico is just 80 years old. That’s the time since the agricultural land was abandoned and the plants took over,” Lugo says. “So we don’t know what they will look like in 200 years’ time.”

A study in Puerto Rico suggests that although nonnatives initially dominate novel ecosystems, over time, native species establish themselves and cover a greater percentage. “Any tree that lives here has to be able to survive the once-every-60-years hurricanes that hit the islands. As a result, we see the well-adapted native trees prevailing over time,” Lugo says.

For many, abandoning the pristine dream is an acceptance of defeat, but Hobbs cautions that there is no time for sentimentality. “The conservation fraternity is still in a grieving mode because they’re seeing what’s lost,” Hobbs says. “I’m focusing on what’s there now. We have a huge opportunity to do better conservation with novel ecosystems, because whatever the future looks like, it will be very different from the past.”

Here in the Galápagos, Gardener hopes to have a hand in deciding what that future looks like.

—GAIA VINCE

Gaia Vince writes on environmental issues in the developing world at wanderinggaia.com.